

D. J. McCARTHY.
ELECTROMAGNETIC APPARATUS.
APPLICATION FILED FEB. 19, 1914.

1,222,431.

Patented Apr. 10, 1917.
4 SHEETS—SHEET 1.

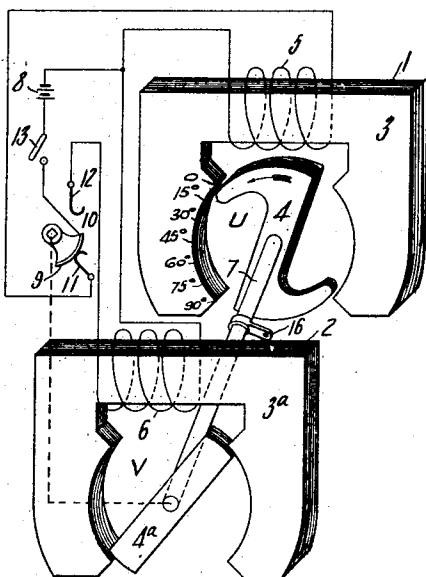


FIG. 1

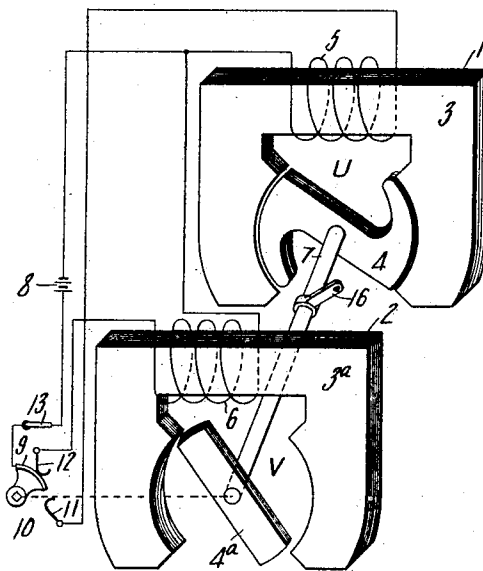
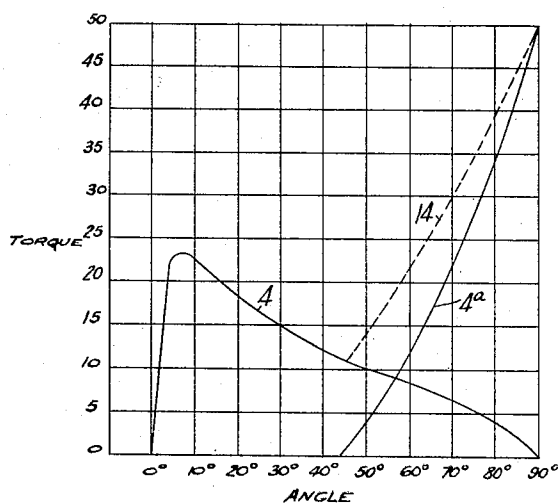


FIG. 2

FIG. 3



WITNESSES

W. T. Stohman
A. L. Vencill

INVENTOR

Daniel J. McCarthy
by *Geo. C. Cross*
His attorney

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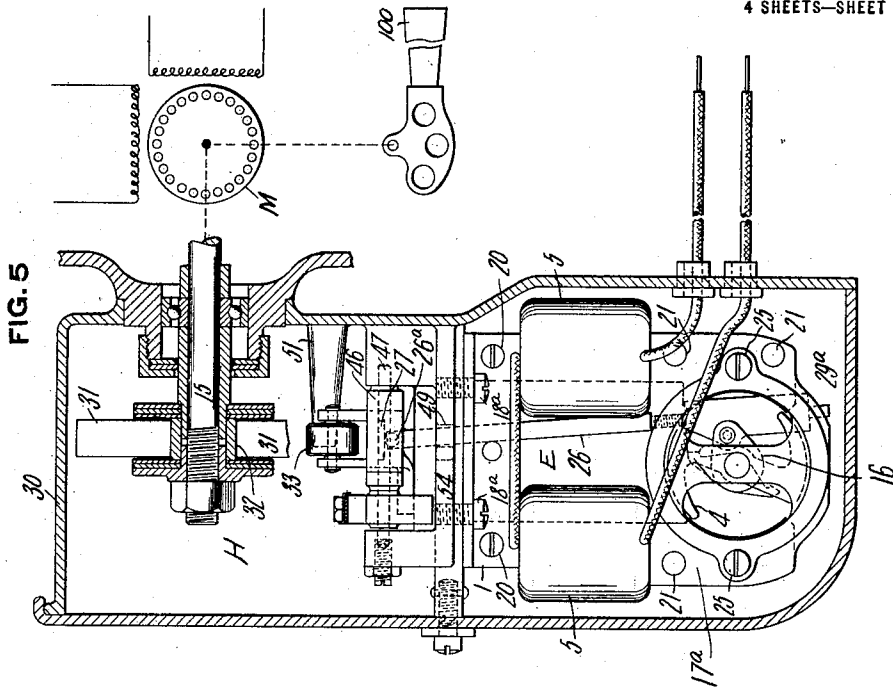
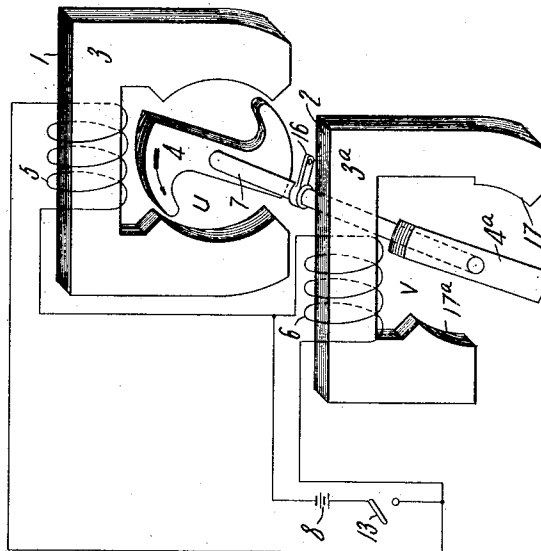


FIG. 4



WITNESSES

W. T. Holman
A. L. Vencill

INVENTOR

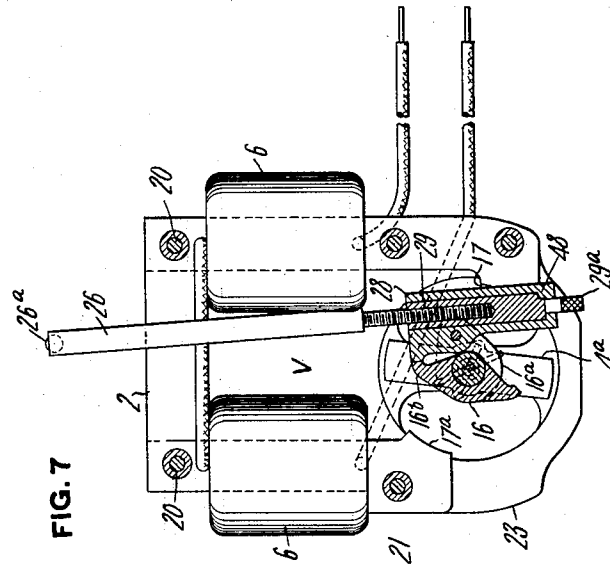
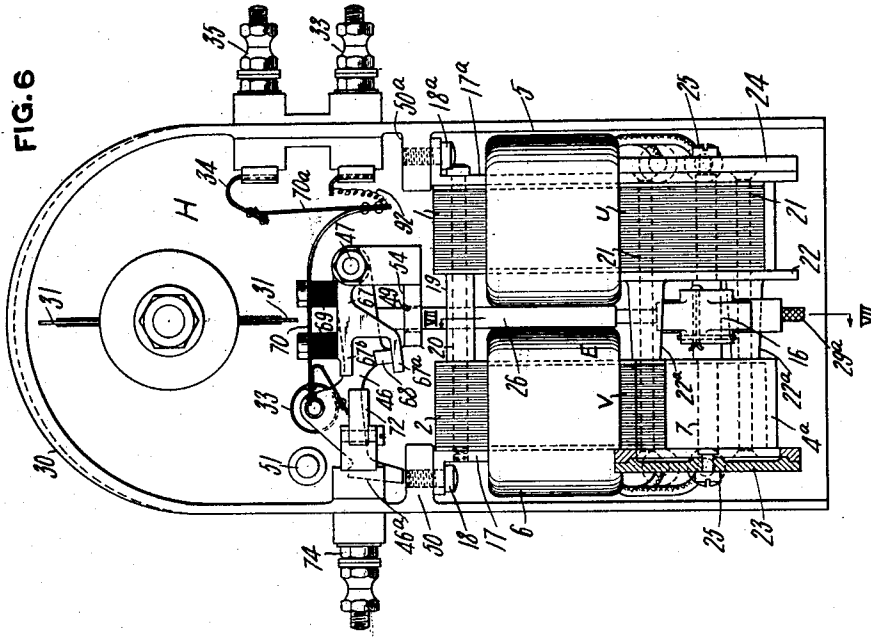
Daniel J. McCarthy
by Geo. C. Cross
His Attorney

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WITNESSES

W. T. Holman
A. L. Vercill

INVENTOR

Daniel J. McCarthy
by Geo. C. Cruise
His attorney

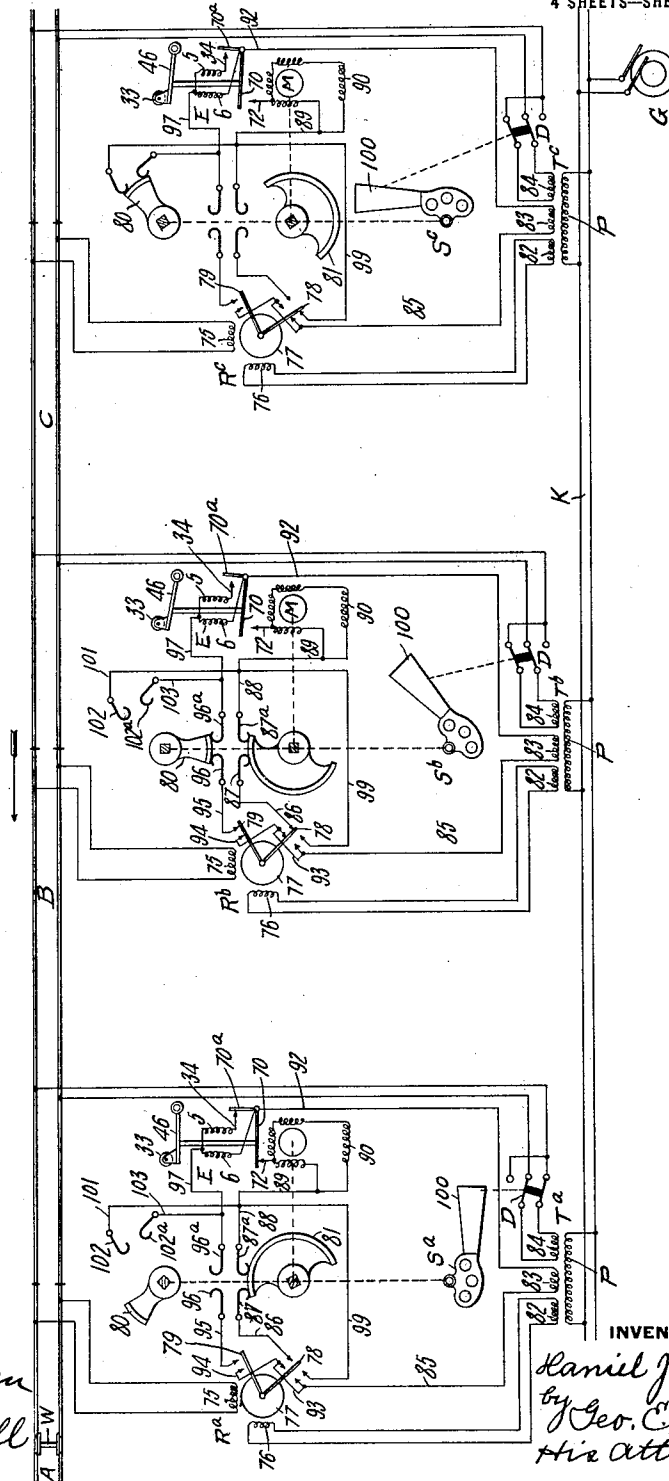
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4 SHEETS—SHEET 4.

FIG. 8



WITNESSES

W. L. Holman
A. L. Vencill

INVENTOR

Daniel J. McCarthy
by *Geo. C. Cross*
his attorney

UNITED STATES PATENT OFFICE.

DANIEL J. MCCARTHY, OF WILKINSBURG, PENNSYLVANIA, ASSIGNOR TO THE UNION SWITCH & SIGNAL COMPANY, OF SWISSVALE, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

ELECTROMAGNETIC APPARATUS.

1,222,431.

Specification of Letters Patent.

Patented Apr. 10, 1917.

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To all whom it may concern:

Be it known that I, DANIEL J. MCCARTHY, a citizen of the United States, residing at Wilkinsburg, in the county of Allegheny and State of Pennsylvania, have invented certain new and useful Improvements in Electromagnetic Apparatus, of which the following is a specification.

My invention relates to electromagnetic apparatus. Apparatus embodying my invention is particularly well adapted for controlling certain types of holding devices for railway signals, although it is not limited to this particular adaptation.

I will describe certain forms of electromagnetic apparatus embodying my invention, showing the application of one form to the control of a signal holding device, and will then point out the novel features thereof in claims.

In the accompanying drawings, Figure 1 is a view, partly in isometric elevation and partly diagrammatic, showing one form of electromagnetic apparatus embodying my invention, the movable parts being in one position. Fig. 2 is a view similar to Fig. 1, but showing the movable parts in another position. Fig. 3 is a view showing the torques exerted on the movable parts of the apparatus shown in Figs. 1 and 2 throughout the extent of their movement. Fig. 4 is a view similar to Fig. 1 but showing a modification of the apparatus shown therein. Fig. 5 is a view showing in side elevation a signal holding device H controlled by electromagnetic apparatus E, which is similar to that shown in Fig. 4. Fig. 6 is a view showing in end elevation the holding device and electromagnetic apparatus shown in Fig. 5. Fig. 7 is a sectional view on the plane indicated by line VII—VII in Fig. 6. Fig. 8 is a diagrammatic view showing three signals each embodying the apparatus shown in Figs. 5 and 6, the parts of the signals being in the positions corresponding to the danger, caution and clear positions of the semaphore.

Similar reference characters refer to similar parts in each of the several views.

Referring first to Figs. 1 and 2, the apparatus here shown comprises two motor devices U and V, each of which comprises an electromagnet 3 or 3^a, and an armature 4 or 4^a. Each electromagnet comprises a field core 1 or 2 and an energizing winding 5 or

6. Each field core and each armature is preferably formed of a plurality of thin laminations of soft iron. As here shown, the pole-pieces of each electromagnet are oppositely located and are recessed to provide a cylindrical field space, and each armature is mounted to oscillate in the cylindrical space thus provided in the corresponding magnet. The armatures 4 and 4^a are both fixed on a shaft 7 which is mounted to oscillate in suitable bearings (not shown), so that the armatures are constrained to oscillate in unison, and this shaft is provided with a crank arm 16 by means of which the oscillations of the shaft may be transmitted to any desired device or devices. The windings 5 and 6 are energized from a source of current 8, and are controlled by a circuit controller 10 operated by shaft 7 and comprising a movable contact 9 and two fixed contact fingers 11 and 12, which circuit controller is so constructed that one winding or the other is energized according as contact 9 is in engagement with finger 11 or 12, and that both windings are energized when contact 9 is in engagement with both fingers 11 and 12. The circuits for the windings may also be controlled by a contact 13 operated by exterior means not shown.

In the form of apparatus here shown, armature 4 is of the well known Z-shape, and armature 4^a is substantially rectangular in shape. These armatures are fixed to shaft 7 in such relation that the maximum torques exerted thereon by the electromagnets occur at different angular positions of the shaft 7, and that as the torque on one armature is increasing, that on the other is decreasing. This relation I will now explain by reference to Fig. 3 as well as to Figs. 1 and 2.

First considering only motor device U, the arc of each pole-face of electromagnet 3 is substantially 90°, and the arc of each leg of armature 4 is also substantially 90°, hence when this armature occupies such position that one of its points is opposite the zero line in Fig. 1, it is evident that the torque exerted thereon by magnet 3 will be zero, that is, the armature will then be balanced. Then as the armature is moved in the direction indicated by the arrow, the torque suddenly rises to a maximum value and draws the armature farther in the same direction; the torque then decreases gradually until it becomes zero, when the armature has swung

90° to the position in which it is shown in Fig. 2. This variation in torque is indicated by the curve 4 in Fig. 3, in which view the horizontal scale represents positions of the armature 4 in degrees corresponding to the angles indicated in Fig. 1, and the vertical scale represents the torque exerted on this armature in convenient units such as inch-ounces. I will assume that armature 4 is limited by suitable means (not shown) to swing between the 5-degree position (in which it is shown in Fig. 1) and the 90-degree position (in which it is shown in Fig. 2). Then if, while the armature occupies the position shown in Fig. 1, winding 5 be energized by closing contact 13, the armature will be swung in the direction of the arrow with constantly decreasing torque until it reaches the 90-degree position at which the torque will be zero.

Considering now motor device V, the armature 4^a is so positioned on the shaft that when armature 4 reaches the 45-degree position, armature 4^a is vertical, hence if winding 6 is then energized the torque exerted on the latter armature by magnet 3^a is zero. But as the armatures continue to move in the direction of the arrow the torque exerted on armature 4^a by magnet 3^a increases to a maximum value at the 90° position. This variation of torque is indicated by curve 4^a in Fig. 3.

The operation of the apparatus shown in Figs. 1 and 2, is as follows: Assuming that the movable parts are in the positions shown in Fig. 1, and that contact 13 be closed by exterior means, winding 5 will then be energized so that electromagnet 3 will draw the armature 4 in the direction of the arrow; winding 6 is not energized at the start, hence armature 4^a has no effect on the torque exerted on shaft 7. The torque exerted on this shaft will then be as indicated by the left-hand half of curve 4 in Fig. 3; that is, the torque will gradually decrease in accordance with the travel of the shaft. When the moving parts reach the 45-degree position, contact 9 will engage contact finger 12, thereby energizing winding 6 so that armature 4^a will then begin to exert torque. Since the torques exerted by the two armatures are in the same direction, the resultant torque on shaft 7 during the remainder of the movement will be as indicated by the dotted line 14 in Fig. 3, which line represents at each point the sum of the torque exerted by armature 4 (represented by curve 4) and that exerted by armature 4^a (represented by curve 4^a). Just before the moving parts reach the 90-degree position, contact 9 leaves contact finger 11, thereby deenergizing winding 5; the reason for this is that at this point armature 4 is exerting no torque on the shaft 7, hence, motor device U is preferably deenergized in order to save energy.

It will be seen from the foregoing that the torque exerted on shaft 7 is comparatively high at the beginning of the movement and yet the maximum value occurs at the end of the movement. This condition is highly desirable in cases wherein a considerable range of movement is desired and at the same time the effective work to be done by the apparatus occurs at the latter part of the movement.

In Figs. 1 and 2 I have shown that apparatus embodying my invention may be employed to give the shaft 7 a movement through an angle of 90°. This range of movement is not always necessary or desirable, and when a smaller range is desired, the form of apparatus shown in Fig. 4 may be employed. Referring now to this view, the motor device U and the shaft 7 are the same as in Figs. 1 and 2, but armature 4^a is so located on the shaft 7 that when this armature reaches the point at which the torque exerted thereon by magnet 4^a is maximum the movable parts will have swung through an angle of only about 50° from the positions shown in the drawing. Furthermore, the pole-pieces of magnet 4^a are preferably cut away as shown, leaving only small portions 17 and 17^a to act on armature 4^a, so that current may be applied to both magnets at the start yet no reverse torque will be exerted on armature 4^a by its magnet. Hence, the circuits for windings 5 and 6 may be controlled by a single contact 13 by means of which these windings are simultaneously energized and deenergized.

If, with the parts in the positions shown in the drawing contact 13 is closed, the maximum torque will immediately be exerted on armature 4 and practically no torque on armature 4^a. The armatures will then swing in the direction indicated by the arrow, the torque on armature 4 constantly decreasing and that on armature 4^a constantly increasing until the 50-degree position is reached, at which the torque on armature 4^a will be maximum. A small torque will still be exerted on armature 4 so that the sum of the two torques will be exerted on shaft 7. The torque curves for the apparatus shown in Fig. 4 are similar to those shown in Fig. 3 except that the range of movement is less.

Referring now to Figs. 5 and 6, I have here shown a railway signal holding device H controlled by electromagnetic apparatus E which is similar to that shown in Fig. 4. The holding device H here shown is substantially the same as that shown in an application filed by John P. Coleman on January 31, 1914, Serial No. 815,673. Briefly described, this device comprises a spindle 15 which is operatively connected with a signal semaphore 100 and with a motor M in such manner as to be rotated when the signal is

moving in either direction; the connection may, for example, be such as is shown in the Coleman application hereinbefore referred to. A collar 32 is operatively connected
 5 with spindle 15 through the medium of a friction clutch, which collar is provided with two radial blades 31 of resilient material. These blades 31 coact with a roller 33, which
 10 is carried by an arm 46 mounted to oscillate on a shaft 47, which shaft is supported in a bracket 54 formed integral with an inclosing box 30. The oscillation of arm 46 is limited by the engagement of the upper and lower ends of a projection 46^a with two lugs 50 and
 15 51 formed in the box 30, the oscillation permitted by these lugs being such that the roller 33 moves into and out of the path of blades 31.

The two field cores 1 and 2 of the electromagnetic apparatus E are mounted as a unit in box 30 in the following manner: These cores are united near their upper ends by bolts 20, and are spaced at the proper distance by sleeves 19 on the bolts.
 20 Near their lower ends they are united by rivets 21 which pass through spacing lugs 22^a formed on a plate 22 which rests against core 1. The cores are suspended from lugs 50 and 50^a formed in the box 30, the suspension being accomplished by means of side plates 17 and 17^a secured respectively to the faces of the cores by the bolts 20 and bolts 25, and also attached to the lugs 50 and 50^a by screws 18 and 18^a. The shaft 7 is
 25 journaled in plates 23 and 24 attached to side plates 17 and 17^a by the screws 25, and this shaft carries the armatures 4 and 4^a as hereinbefore explained. Fixed also to the shaft 7 is the crank 16 which crank is adjustably connected, by means which I will hereinafter explain, with a link 26 which extends upwardly and controls the arm 46. As
 30 here shown, the under surface of arm 46 is hollowed out and is provided with a hard steel plate 27, and a hard steel ball 26^a is set into the upper end of link 26, which ball coacts with the plate 27, thereby providing hardened surfaces at the point of greatest wear.

Referring particularly to Fig. 7, the means which I have here shown for connecting the crank 16 and the link 26 is as follows: The crank comprises two jaw members 16^a, and also a member 16^b integral with the
 35 jaws and shaped as shown, which latter member serves as a stop as will later appear. Pivottally mounted in the jaw members 16^a is a socket 28 into which fits freely a member 29 having a longitudinal threaded bore.
 40 The lower end of link 26 is threaded to screw into the bore of member 29. The lower end of member 29 is provided with a knurled extension 29^a which projects through a hole in socket 28 and by means of
 45 which the member 29 may be turned by hand.

The lower end of member 29 is provided with a notch which fits over a shoulder 48 in the socket 28 and prevents the member from turning in the socket when the member is at the bottom of the socket; the member
 50 may, however, be turned by pushing it upward until the shoulder 48 disengages from the notch in the member. During this turning process, the link 26 is prevented from turning by virtue of the fact
 55 that this link is square and that it passes through a square hole 49 in the bracket 54 which supports shaft 47. It will be seen, therefore, that the relation between the link 26 and the shaft 7 may be varied by pushing upwardly on the extension 29^a and then turning this extension. The downward movement of link 26 is limited by the engagement of the upper wing of member 16^b with the outside wall of socket 28, and the
 60 upward movement is similarly limited by the engagement of the lower wing of member 16^b with the socket.

It will be seen that when the armatures 4 and 4^a are in the positions shown in Figs. 5 and 7, arm 46 is down so that roller 33 is out of the path of blades 31, but that when the windings 5 and 6 are energized, thereby swinging the armatures in counter-clockwise direction, as viewed in Figs. 5
 65 and 7, link 26 is raised, thereby raising arm 46 so that the roller moves into the path of the blades.

Arm 46 is employed to control contacts which in turn control the circuits for windings 5 and 6 and the circuit for the motor M which moves the signal. Mounted to oscillate on shaft 47, which shaft carries arm 46, is a second arm 67 on which a contact spring 70 is supported by insulation studs
 70 69. One end of spring 70 is connected through a flexible conductor 92 with a terminal post 33 mounted in box 30 and the other end is adapted to make contact with a block 72 forming part of another terminal post 74 mounted also in box 30. Fixed to the spring 70 is another spring 70^a which is adapted to make contact with a finger 34 carried by a third terminal post 35 mounted also in box 30. The arm 67 is bifurcated to form two fingers 67^a and 67^b between which is located a lug 68 projecting from arm 46. When arm 46 is in its lowest position lug 68 engages the lower finger 67^a and thereby holds arm 67 down so that contacts 70—72
 75 and 70^a—34 are closed. When, however, arm 46 is raised by the electromagnetic apparatus E, lug 68 strikes the upper finger 67^b and raises arm 67 thereby opening contact 70—72 and also contact 70^a—34. The advantages of this means for operating the contact carrying arm 67 are pointed out in the application by John P. Coleman hereinbefore referred to.

Referring now to Fig. 8, I have here

shown a stretch of railway track provided with several signals each having an electromagnetic apparatus E embodying my invention. The normal direction of traffic through the stretch is as indicated by the arrow. The stretch is divided into block sections A, B, and C, which sections are protected by signals S^a, S^b and S^c, respectively, which signals are each adapted to indicate danger, caution and clear, and which signals are controlled by track circuits for the several sections. Each signal comprises a semaphore 100 biased to the danger position, a motor M for moving it to the caution and clear positions, electromagnetic apparatus E, and a suitable holding device controlled thereby for stopping the signal at the caution and clear positions and for holding it in the latter positions against its bias, and contacts 80 and 81, operatively connected with the semaphore. Alternating current for the track circuits and for the operation of the signal motors and holding devices is obtained from transformers T^a, T^b and T^c, whose primaries are connected with transmission mains K to which current is supplied by generator G. The signals are controlled by relays R^a, R^b, and R^c, which relays, as here shown, are of the induction motor type, each comprising two windings 75 and 76, and a cylindrical rotor 77 which operates contact fingers 78 and 79. Winding 75 of each relay is connected with the track rails of the section over which the corresponding signal governs traffic, and winding 76 is connected with a secondary winding 82 of the adjacent transformer T. Signaling current is supplied to the track rails of each section from a secondary winding 84 of a transformer T through the medium of a pole-changer D operated by the signal at the exit end of the section, which pole-changer is reversed during the movement of the signal between danger and caution, but is not affected by the movement of the signal between caution and clear.

The operation of the apparatus shown in Fig. 8, is as follows: As shown in the drawing, block section A is occupied by a car or train W, so that signal S^a is in the stop position, signal S^b in the caution position, and signal S^c is in the clear position. When the car or train W passes out of section A into the section next in advance, relay R^a will be energized in such direction that its contact fingers will move upwardly, thereby closing the following circuit through the windings of motor M—from secondary 83 of transformer T^a through wires 85 and 93, contact finger 78, wire 86, contact 87, segment 81, contact 87^a, wires 88 and 89, windings of motor M (including a phase displacing reactance 90 in series with one winding), contact 72—70, wire 92 to secondary 83. The motor will then drive the signal toward cau-

tion, and just as the latter position is reached, segment 80 will bridge contacts 96 and 96^a, thereby energizing the windings of the electromagnetic apparatus E through the following circuit—from secondary 83 through wires 85, 93 and 94, contact finger 79, wire 95, contact 96, segment 80, contact 96^a, wire 97, windings 5 and 6 in multiple (winding 5 being connected through contact 70^a—34), wire 92 to secondary 83. Apparatus E then raises arm 46, thereby opening the motor operating circuit at contact 72 and also raising roller 33 into the path of the blades 31, so that the signal is instantly brought to rest in the caution position. During the raising of arm 46 contact 70^a—34 is opened, thereby deenergizing winding 5, but this does no harm, because by referring back to Fig. 4 it will be seen that after shaft 7 has swung around through a part of its stroke, the torque exerted by armature 4 becomes very small, whereas that exerted by armature 4^a increases and is sufficient to hold the arm 46 in the rest position. The parts of the signal then occupy the positions in which the parts of signal S^b are shown in Fig. 8. During the movement of signal S^a from danger to caution, the semaphore 100 of this signal has reversed the corresponding pole-changer D, thereby reversing the current in winding 75 of relay R^b so that the contact fingers of this relay are swung downwardly. The opening of contact finger 79 opens the circuit for winding 6 so that arm 46 falls, thereby moving roller 33 out of the path of blades 31 and also closing contact 72—70. This latter contact closes a circuit through the motor from secondary 83 of transformer T^b, through wire 85, contact finger 78, wires 99 and 89, windings of motor M, contact 72—70, wire 92 to secondary 83. The motor then drives the signal toward the clear position and just as the latter position is reached segment 80 bridges contacts 102—102^a, thereby energizing the electromagnetic apparatus E through the following circuit—from secondary 83 through wire 85, contact finger 78, wires 99 and 101, contact 102, segment 80, contact 102^a, wires 103 and 97, windings 5 and 6, wire 92 to secondary 83. Arm 46 is thereby raised, opening the motor circuit and stopping the signal positively in the clear position by means of roller 33 and also opening the branch including winding 5.

One important feature of electromagnetic apparatus embodying my invention is that it develops a large amount of mechanical energy for a small amount of electrical energy; in other words, it is highly efficient. Another advantage is that the movable member (the shaft 7 in the illustrated embodiments) may be swung through a considerable angle without the necessity for connections for multiplying the amplitude of movement.

Although I have herein shown and described only certain forms of electromagnetic apparatus embodying my invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention. And although I have shown apparatus embodying my invention employed to control a railway signal holding device, I do not wish to limit myself to employing the apparatus for this specific purpose, for there are many other purposes to which it is well adapted.

Having thus described my invention, what I claim is:

1. In combination, two motor devices each comprising a fixed field member and a movable armature, one armature being Z-shaped and the other a straight bar, means for operatively connecting said armatures, means for constraining said armatures to oscillation through a limited angle such that in one extreme position the torque exerted on the Z-shaped armature is at maximum value and the torque exerted on the bar armature is at minimum value, and that in the other extreme position the torque exerted on the Z-shaped armature is at minimum value and the torque exerted on the bar armature is at maximum value.

2. In combination, two motor devices each comprising a fixed field member and a movable armature, one armature being Z-shaped and the other a straight bar, means for operatively connecting said armatures, means for constraining said armatures to oscillation through a limited angle such that in one extreme position the torque exerted on the Z-shaped armature is at maximum value and the torque exerted on the bar armature is at minimum value, and that in the other extreme position the torque exerted on the Z-shaped armature is at minimum value and the torque exerted on the bar armature is at maximum value, and means for energizing only the motor device comprising the Z-shaped armature from the first-mentioned extreme position of the

armatures to an intermediate position, and for energizing the other motor device from such intermediate position to the other extreme position, the device comprising the Z-shaped armature being deenergized after the other motor device becomes energized.

3. In combination, two motor devices each comprising a fixed field member and a movable armature, one armature being Z-shaped and the other a straight bar, means for operatively connecting said armatures, means for constraining the armatures to movement through a limited angle such that the torque exerted on the Z-shaped armature decreases while the armatures are moving from one extreme position to the other, the angular relation of the bar armature to its field member and to the other armature being such that the torque exerted thereon by its field member increases during the said movement and reaches maximum value at the latter extreme position.

4. In combination, two motor devices each comprising a fixed field member and a movable armature, one armature being Z-shaped and the other a straight bar, means for operatively connecting said armatures, means for constraining the armatures to movement through a limited angle such that the torque exerted on the Z-shaped armature decreases while the armatures are moving from one extreme position to the other, the angular relation of the bar armature to its field member and to the other armature being such that the torque exerted thereon by its field member increases during the said movement and reaches maximum value at the latter extreme position, the pole-pieces of the field member with which the bar armature is associated being cut away so that they exert no counter torque on the bar armature.

In testimony whereof I affix my signature in presence of two witnesses.

DANIEL J. McCARTHY.

Witnesses:

A. HERMAN WEGNER,
R. L. KISTLER.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."